



NEXRAD MIGFA STATUS

Presentation to NEXRAD TAC

May 22, 2002

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Outline

- **MIGFA overview**
- **Examples of recent NEXRAD MIGFA enhancements**
- **Scoring results**
- **Planned enhancements**
- **Software benchmarks and specifications**
- **Future activities**

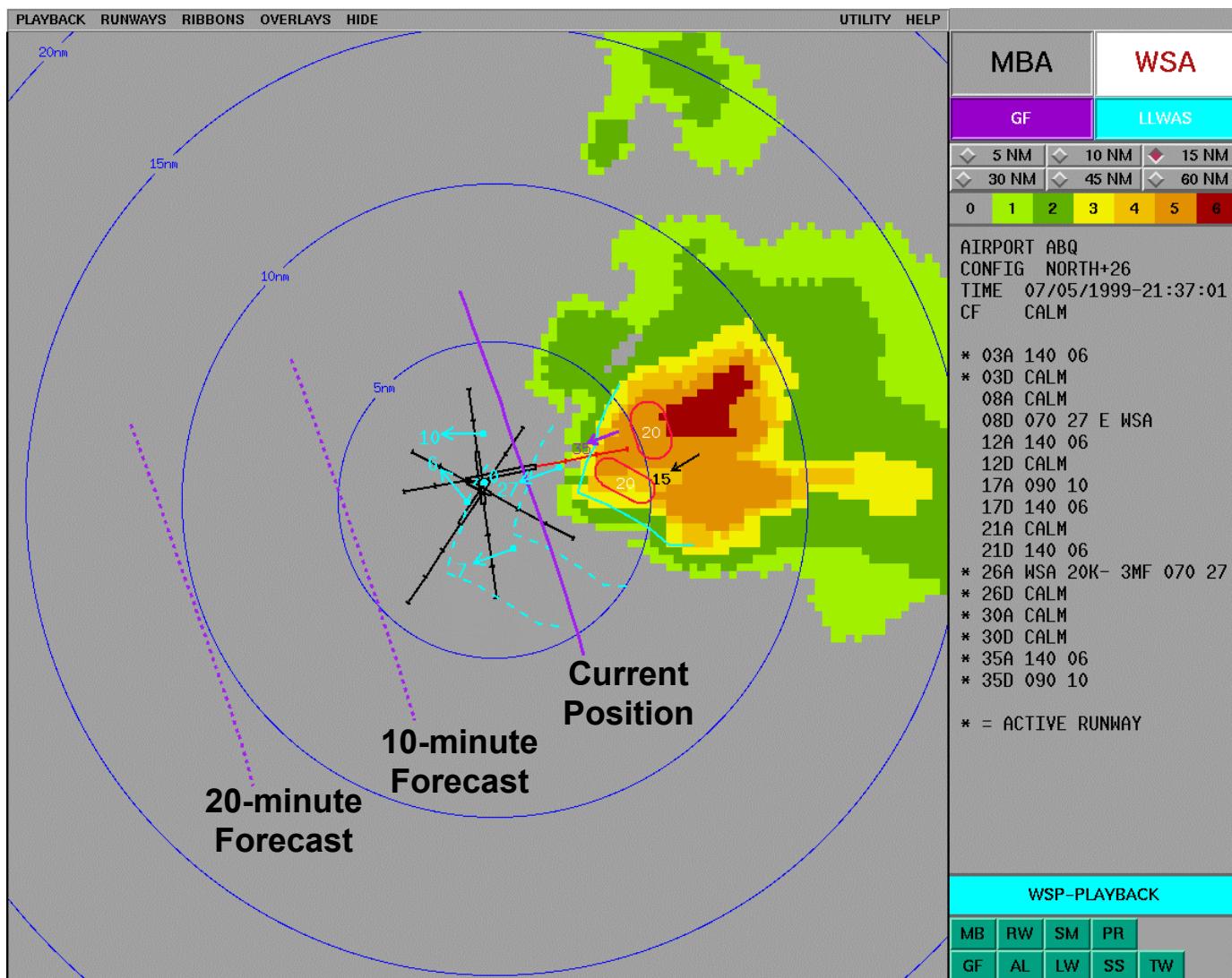


What is MIGFA?

- **Machine Intelligent Gust Front Algorithm originally developed for FAA**
 - Multi-dimensional image processing
 - Fuzzy logic, data fusion, delayed thresholding
- **Gives current and future locations of gust fronts and other wind shift boundaries, plus estimates of wind shear and winds behind the front**
- **Important component of three FAA systems:**
 - ASR-9 WSP (presently being deployed)
 - TDWR (MIGFA currently running in all TDWRs)
 - Integrated Terminal Weather System (ITWS)
- **Used by FAA to improve air safety, airport planning**



Gust Front Detection on Situation Display





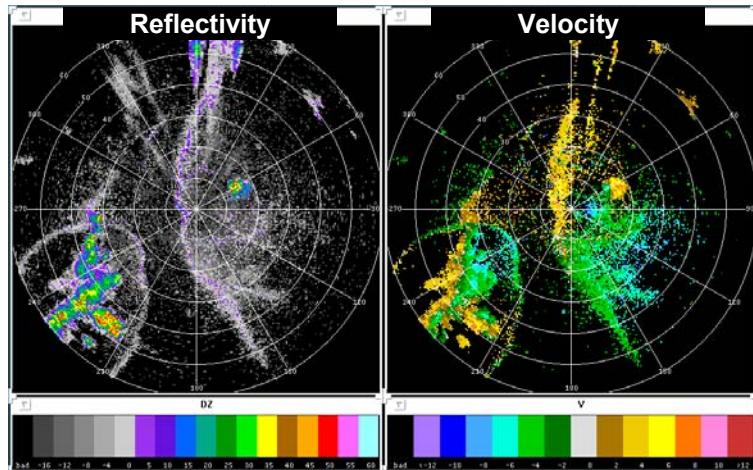
NEXRAD MIGFA Benefits

- **NWS**
 - Assist in issuing high wind and damaging wind warnings
 - Assist NWS forecasters in anticipating:
 - Surface wind shifts
 - Convergence zones (favored locations of convective initiation)
 - Tornados (strong convergence or GF collision points may be precursors)
- **FAA**
 - Gust front warnings for airports without TDWR or WSP
 - Alternative for TDWR when TDWR is unavailable or poor data quality (second trip contamination, bad viewing angle)
 - Useful input to other ITWS products (Terminal Winds, TCWF)
- **Air Force / DOD**
 - Avoid damage from straight-line winds
 - Wind shear warnings for DOD aircraft operations
 - Needed for future convective weather forecast algorithms

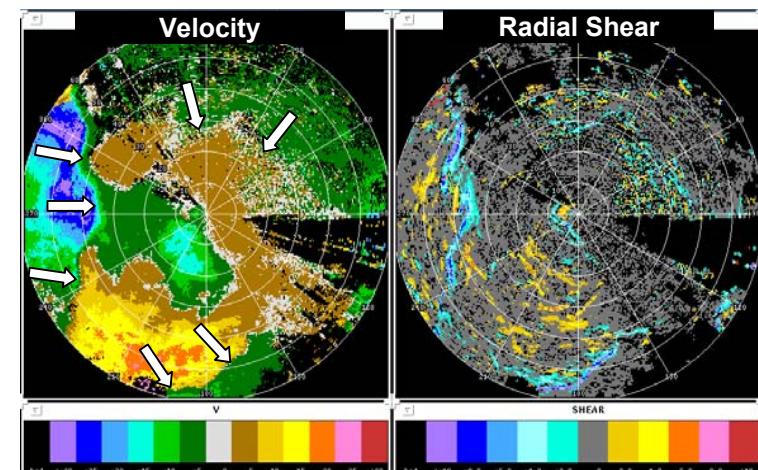


Radar Gust Front Signatures

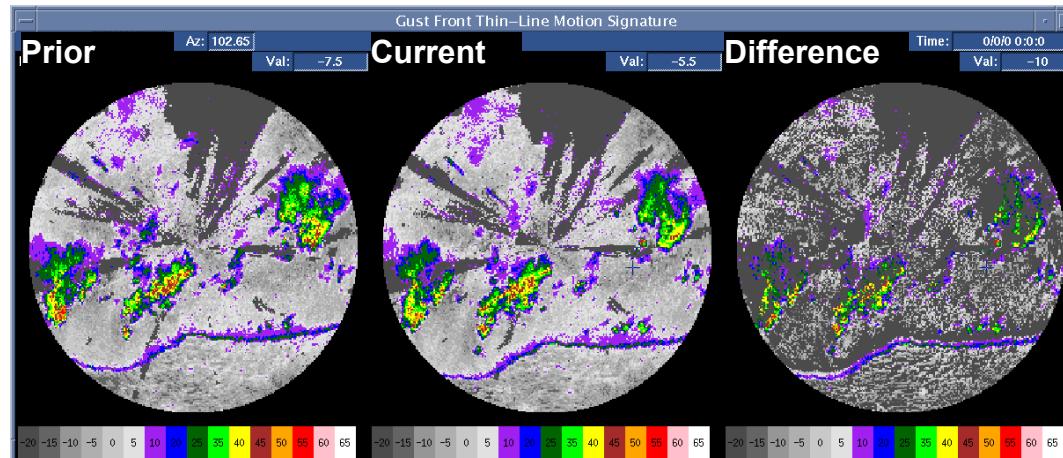
Reflectivity and Velocity Thin Lines

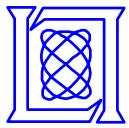


Velocity Convergence

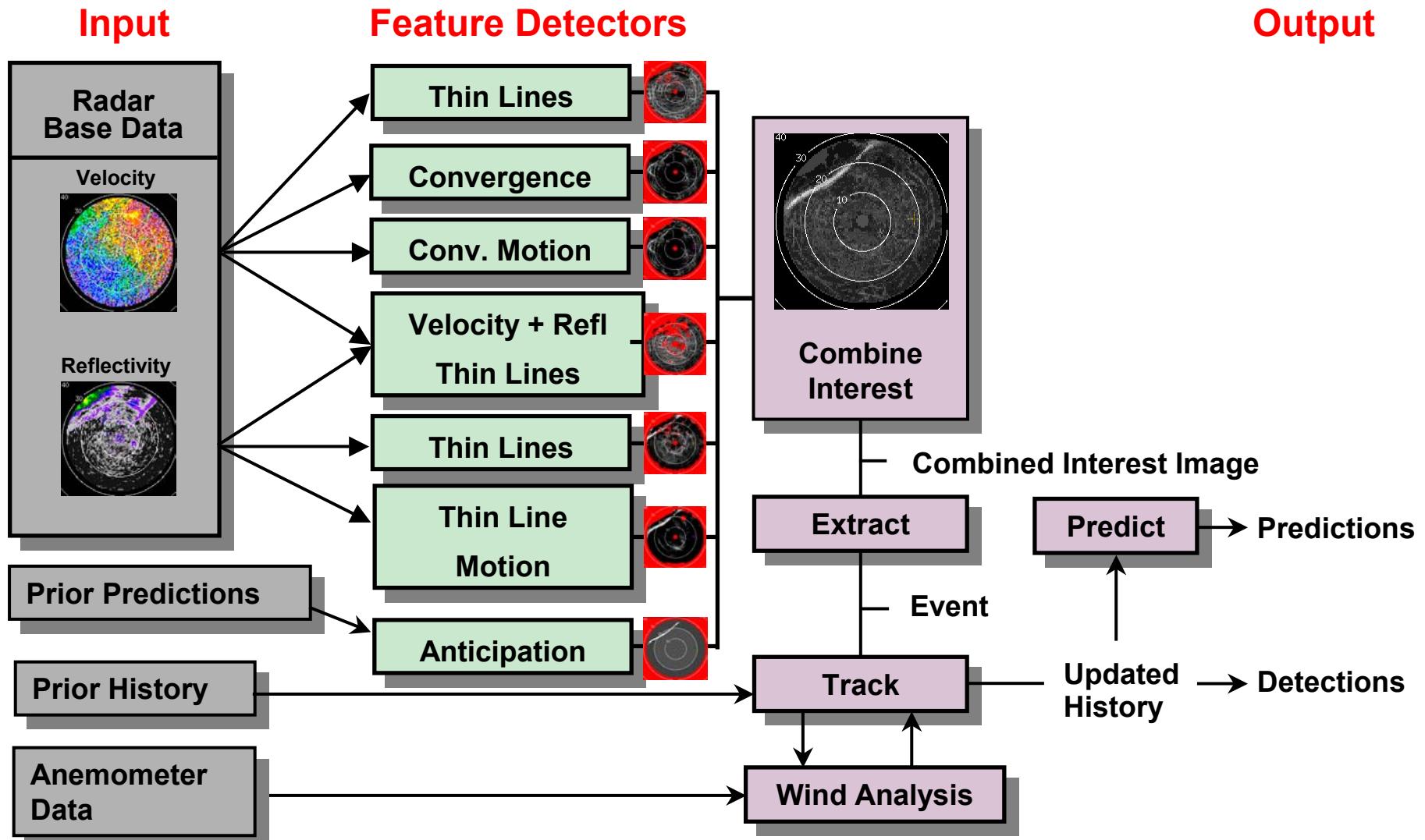


Motion



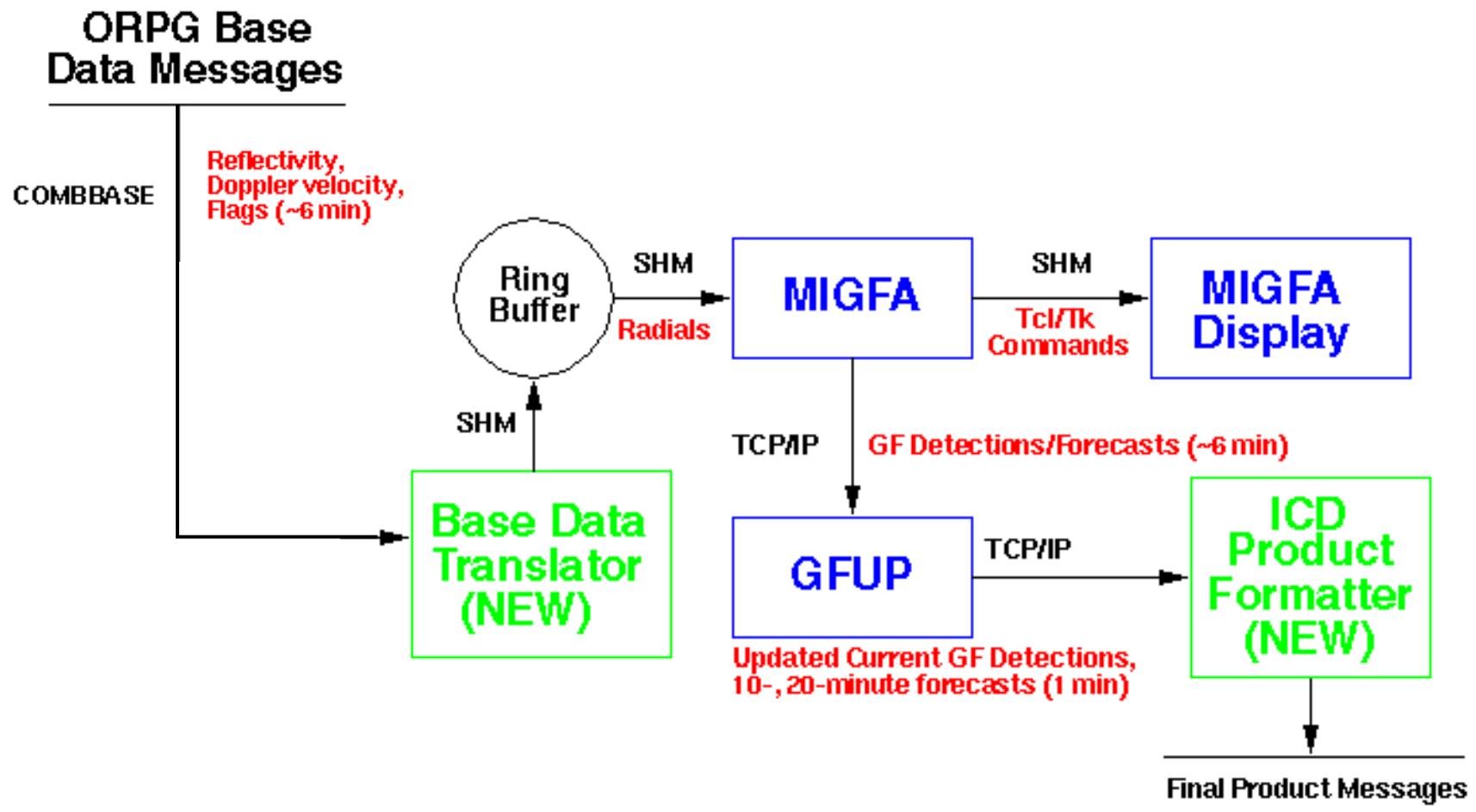


Machine Intelligent Gust Front Algorithm (MIGFA)





NEXRAD MIGFA Process Diagram





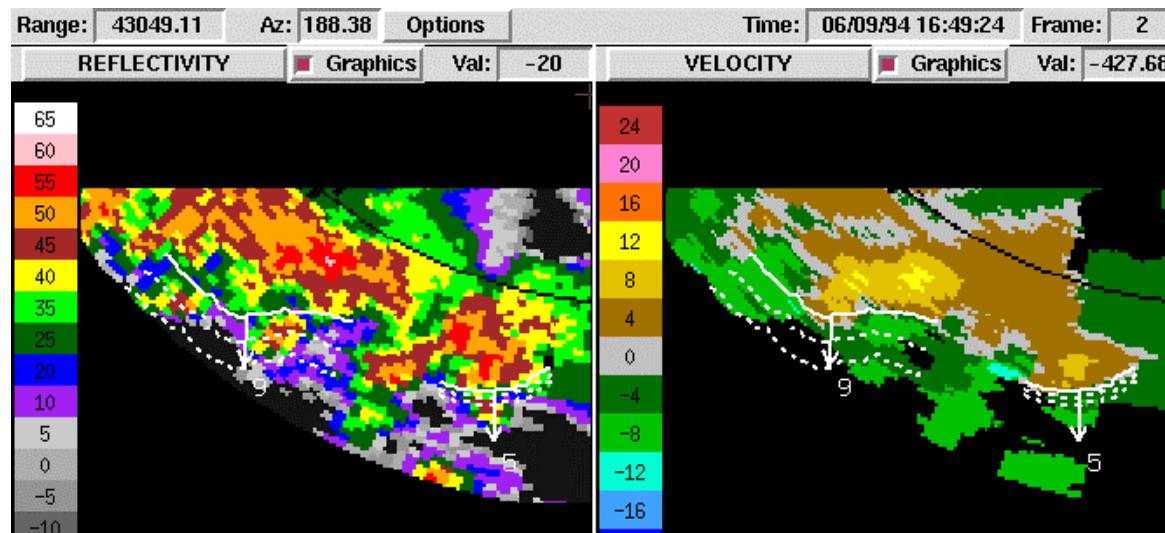
Issues Identified with Initial Tests of NEXRAD MIGFA

- **1999 test at Sterling, VA WSFO**
 - NSSL report on performance.
- **Initial “sensitized” version too sensitive**
 - Too many detections on small, transient convergence features
 - False detections on thin, light rain bands
- **Not enough use of valid thin line signatures**
 - Some obvious boundaries missed due to lack of associated convergence signature
- **Fragmented detections**
 - Causes: storm cell obscuration, missing data
- **Recent enhancements have been made to address these issues**

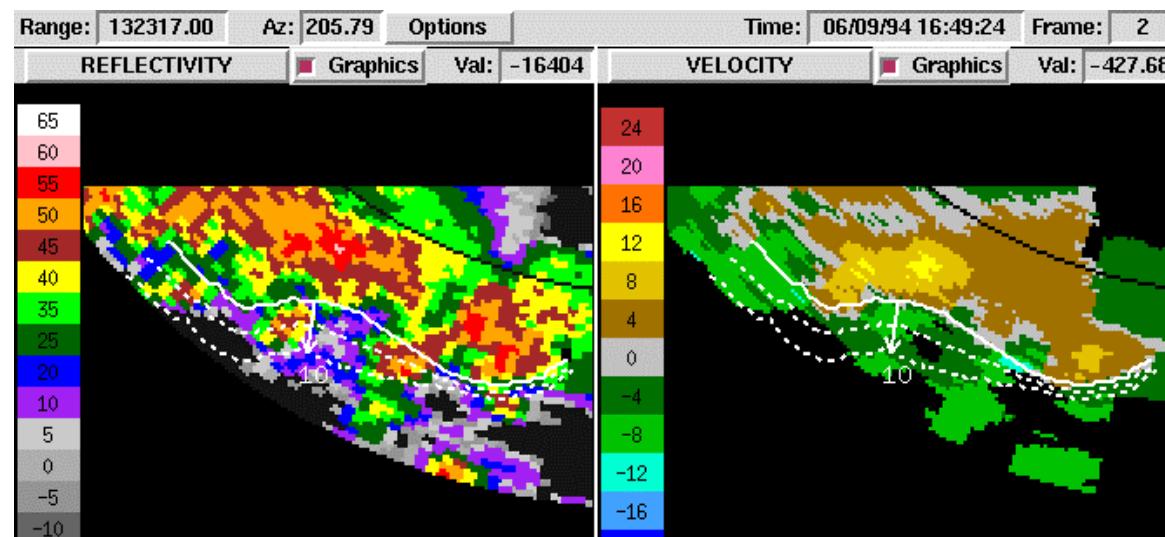


NEXRAD MIGFA Enhancements Connecting Compatible Segments

Without
Connecting



With
Connecting

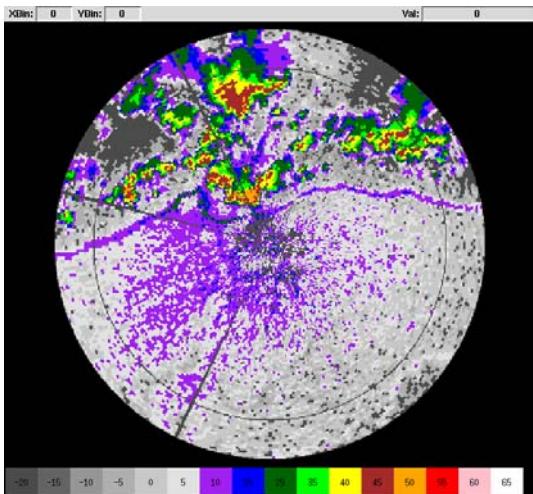




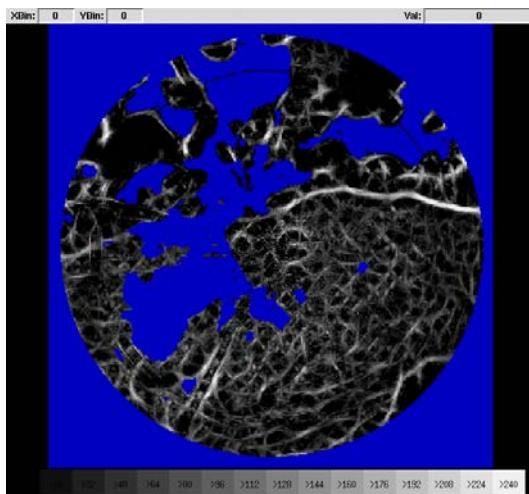
NEXRAD MIGFA Enhancements

Adaptive Thin Line Detection

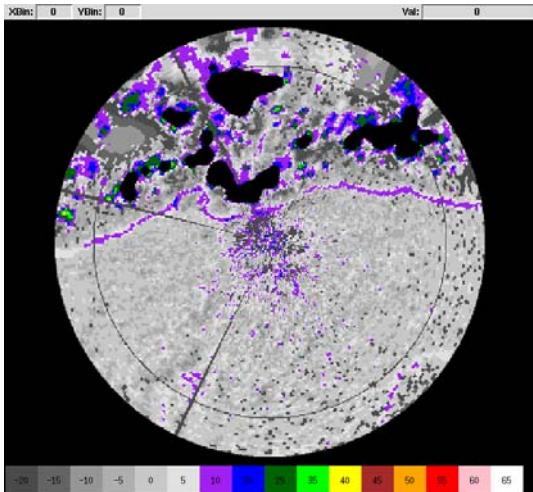
**Original
Reflectivity
Image**



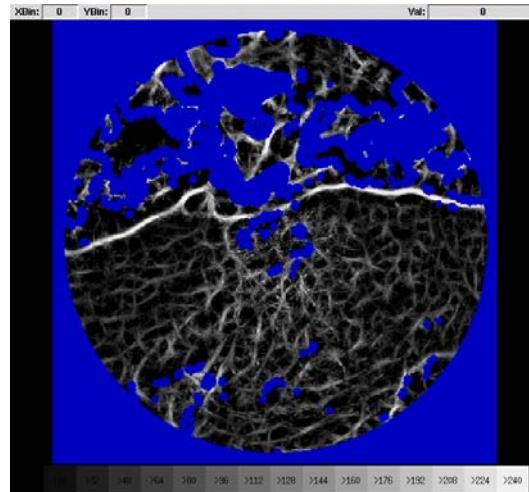
**Original Thin
Line Interest
Image**



**“Normalized”
Reflectivity
Image**



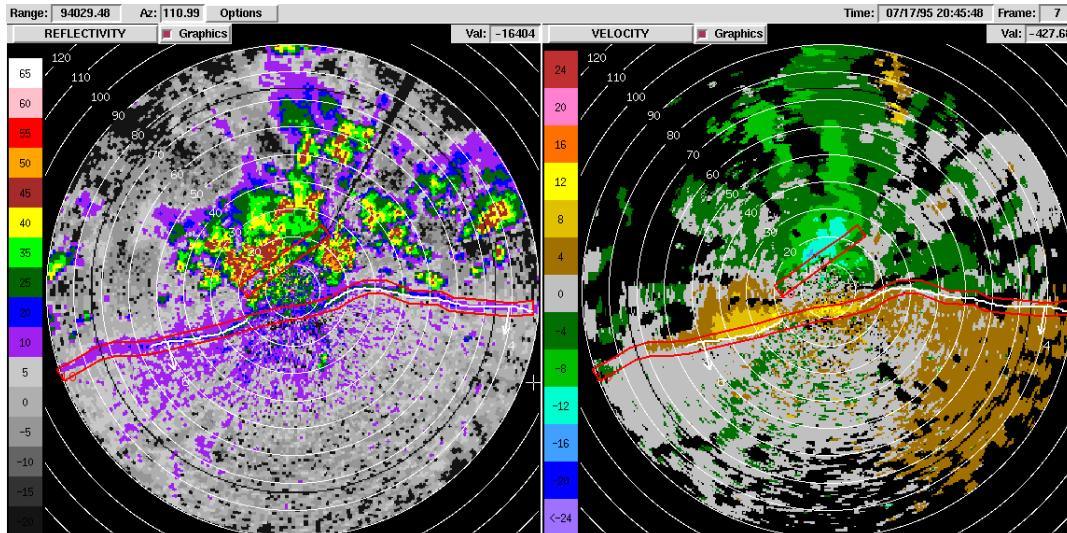
**Thin Line
Interest
After
Reflectivity
Normalization**



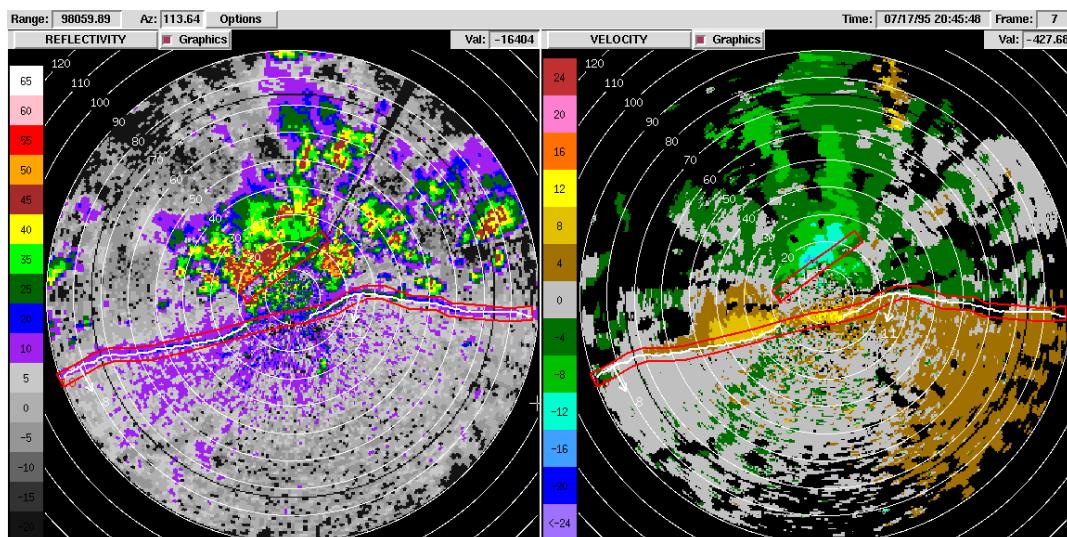


NEXRAD MIGFA Enhancements Extending Chains Along Thin Lines

Without Thin Line Extension



With Thin Line Extension





NEXRAD MIGFA Scoring Results

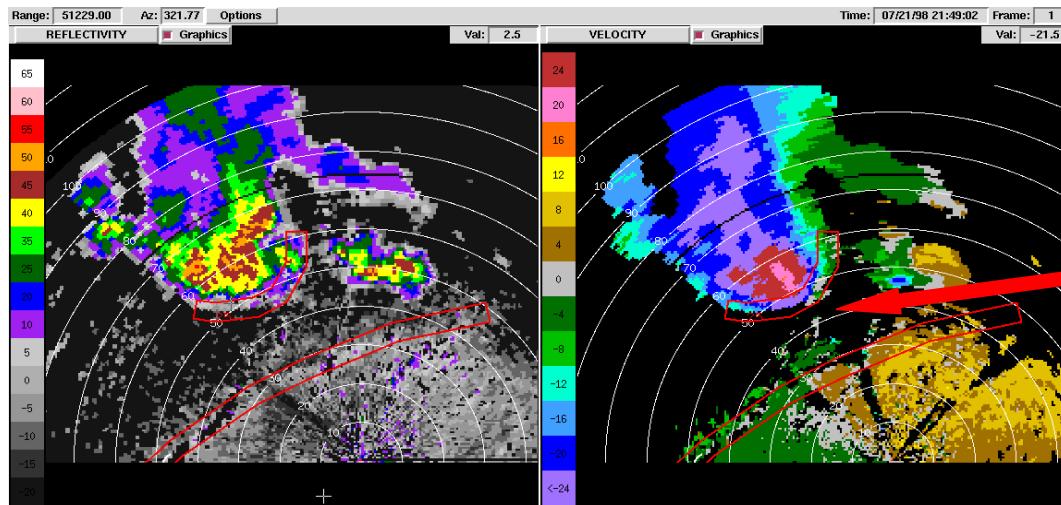
| | POD, PLD (By ΔV Strength in m/s) | | | | | PFA, PFD |
|------------------------------|---|-------------------|-------------------|---------------|-------------------|--------------------|
| | < 10 | 10-15 | 15-25 | > 25 | All | |
| POD, PFA (Event Scoring) | 0.56 (233/481) | 0.84 (237/281) | 0.92 (151/164) | 0.50 (1/2) | 0.72 (622/865) | 0.35 (668/1938) |
| PLD, PFD (Length Scoring) | 0.61 | 0.67 | 0.59 | 0.34 | 0.63 | 0.31 |

- **14 cases**
 - Memphis, TN: 10 cases, 660 scans
 - Sterling, VA: 4 cases, 262 scans
 - Mix of airmass and line storms
- Truth database created by NCAR, LL
- Only two scans in > 25 m/s category. Missing data is cause of apparent low POD (see next slide).



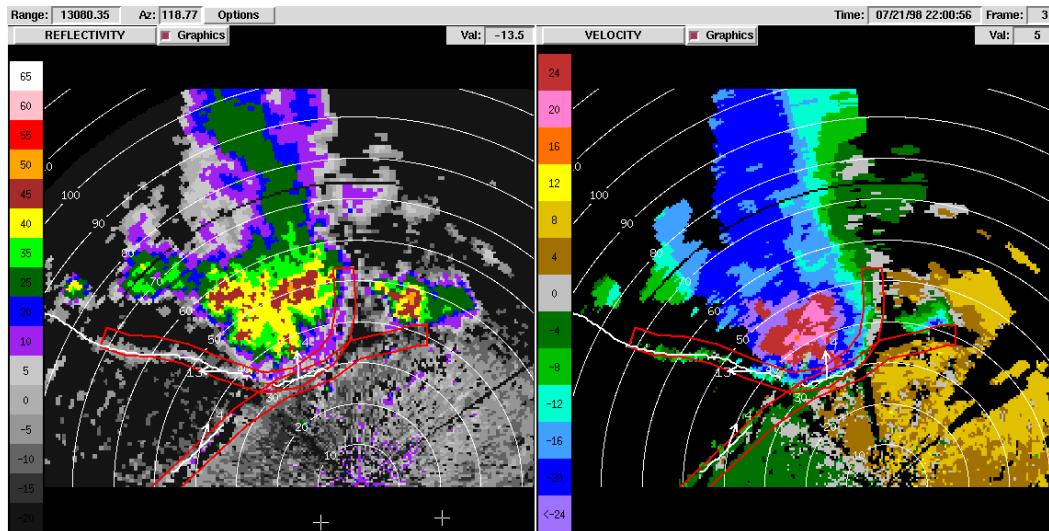
Late Detection Due to Missing Data

07/21/98
21:49:02 GMT



Missing Data
Prevents
Detection of
Convergence

07/21/98
22:00:56 GMT



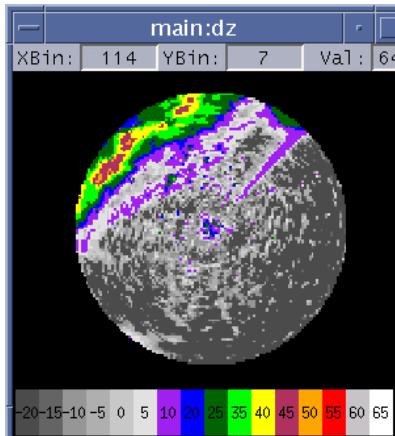
Velocity
Convergence,
Thin Line
Signatures Permit
Detections



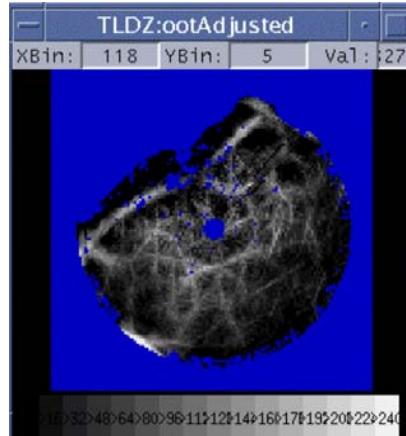
Planned Algorithm Enhancements

- Enhancement of linestorm-aligned interest
 - Detect linestorm regions via a linestorm detector
 - Boost interest of various interest images when they are coincident with linestorms and similarly oriented
 - Can aid detections of embedded fronts especially at time of radar crossover
 - Can aid detections in absence of velocity data

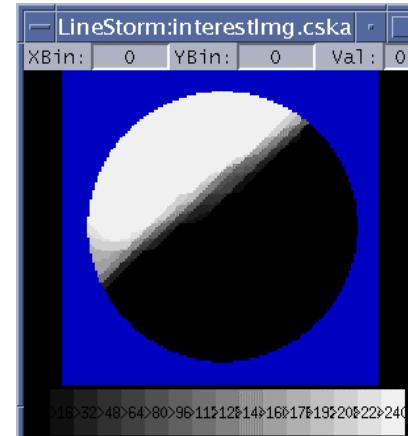
Reflectivity



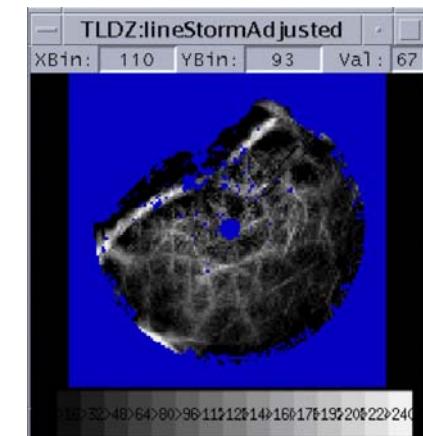
Initial Gust Front
Thin Line Interest



Line Storm Interest



Boosted Gust Front
Thin Line Interest





Planned Algorithm Enhancements (cont)

- Process data from next highest tilt in addition to 0.5 deg tilt
 - Improve gust front observability at short range (less clutter obscuration)
 - Additional vertical extent information can be used to reject thin line echoes associated with higher altitude weather features (e.g. rain showers)
- Incorporate velocity “thin line” detection
- Implement and test James/Houze 4-D velocity dealiaser (4DD)



NEXRAD MIGFA/GFUP Specifications

| | |
|---|--|
| Range Coverage | 105 km |
| Azimuthal Coverage | 360 deg |
| Elevation Coverage | 0.5 deg |
| Update Rate With GFUP Without GFUP | 60 seconds (using extrapolations) NEXRAD volume scan rate |
| Processing Time | Approximately 1 min on 440 MHz processor (Sun Ultra 10/440) |
| Memory Usage | Up to 70 mbytes (varies with wx) (recommend 96 mbytes) |
| Lines of Code <u>MIGFA</u> <u>GFUP</u> <u>Support Libraries</u> <u>Total</u> | 24,000 3,500 38,500 66,000 |



What Next?

- Continue development and testing of planned enhancements
- NEXRAD MIGFA will run on 21 radars in Corridor Integrated Weather System (CIWS)
 - Analysis of results folded into improvements in MIGFA
 - Latest version of MIGFA will feed automated convective weather forecast in 2003
- NEXRAD MIGFA in ORPG will be tested at 4 ITWS demo sites
 - Operational in 2003
 - Will contain improvements from 2002 testing